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Maximum Potential Preventive Effect of Hip Protectors

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OBJECTIVES: To estimate the maximum potential preventive effect of hip protectors in older persons living in the community or homes for the elderly.

DESIGN: Observational cohort study.

SETTING: Emergency departments in the Netherlands.

PARTICIPANTS: Hip fracture patients aged 70 and older who visited the emergency departments of five hospitals in the Netherlands (n = 520).

MEASUREMENTS: Using the risk score of the Dutch Guidelines for Osteoporosis, how many patients had a high risk for fractures was retrospectively assessed. In addition, the circumstances of the hip fracture were assessed (n = 299). Four factors were specified that might influence the maximum potential preventive effect of hip protectors: (1) hip fracture occurred in persons having a low risk, (2) hip fracture was not the consequence of a fall, (3) hip fracture occurred during circumstances that preclude the use of hip protectors, and (4) hip fracture occurred during the night.

RESULTS: When providing hip protectors to women at high risk of fractures, 48.2% of all hip fractures could have been prevented.

CONCLUSION: Many hip fractures occur in persons with a low risk for hip fracture or under circumstances that preclude the use of hip protectors. It was estimated that the maximum potential preventive effect of hip protectors is approximately 50% in older women living in the community or homes for the elderly. The actual preventive effect will be lower and depends on the acceptance and effectiveness of hip protectors and adherence to wearing them. **J Am Geriatr Soc 55:507–510, 2007.**

Key words: hip fracture; preventive effect; hip protector; elderly

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Hip protectors might lead to a marginal but statistically significant reduction in the incidence of hip fractures in nursing homes and homes for the elderly.[1,2] In older people living in their own homes, there is no evidence of the effectiveness of hip protectors from randomized, controlled trials.[1,2] In the Amsterdam Hip Protector Study, hip protectors were not effective in preventing hip fractures in a mixed population of residents of nursing homes, homes for the elderly, and apartment houses for the elderly.[3] Moderate adherence, which is a concern in most hip protector studies, might partly explain this.[4]

The number of hip fractures prevented by hip protectors further depends on the definition of the high-risk group. In the Netherlands, the Dutch Guidelines for Osteoporosis contain a risk score that is designed to predict osteoporotic fractures.[5] This risk score consists of well-known risk factors for osteoporosis (fracture since the age of 50, prevalent vertebral fracture, low body weight, >4 weeks in bed or wheelchair during the previous year, and corticosteroid use). When providing hip protectors only to elderly persons at high risk, some hip fractures may not be prevented because they occur in the low-risk group.

Furthermore, hip fractures may occur in the high-risk group under circumstances that preclude the use of hip protectors. Of the people who wore the hip protectors regularly in the Amsterdam Hip Protector Study, not all were wearing the hip protector at the time of the hip fracture.[3] The most important reason was that most people did not want to wear the hip protector during the night. As a consequence, some of the hip fractures occurred late in the evening or early in the morning when the hip protector was not worn. In addition, people might fracture their hip during activities in which hip protectors cannot be worn, for example when going to the toilet or bathing. Several authors have already described the circumstances of hip fractures or tried to predict which falls may result in injuries;[6–12] the present study focused on circumstances that preclude the use of hip protectors.

The objective of this study was to estimate the maximum potential preventive effect of hip protectors in persons living in the community or in homes for the elderly. To examine this, it was estimated how many patients who were at high risk for hip fractures could be offered hip protectors, because they may not be effective in patients at low risk. Furthermore, the circumstances of hip fractures were

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described to identify circumstances that preclude the use of hip protectors. Although there are several descriptions of acceptance and adherence and the reasons for nonacceptance and nonadherence, this is the first study that sets out to explore in detail other mechanisms that might significantly affect hip protector effectiveness data.

METHODS

Inclusion and Exclusion Criteria

All hip fracture patients aged 70 and older who consecutively visited the emergency departments of five hospitals during 1 year were registered. The hospitals were located in three different regions of the Netherlands (Amsterdam, Zwolle, and Oss and surroundings), together forming a representative sample of the Dutch population with regard to urbanization.[13] One of the hospitals was a university hospital; the others were non-university hospitals. Of the registered hip fracture patients, all patients living in the community or in a home for the elderly (including apartment houses for the elderly and service flats) before the fracture were invited for an interview. Patients who came from a nursing home and patients who sustained a hip fracture caused by a traffic accident or bone metastases were excluded. If a patient had fallen from a bicycle without colliding with other traffic, this was not considered to be a traffic accident. For practical reasons, patients who entered the emergency department but were subsequently admitted to other hospitals were not approached for an interview. The medical ethical committee of the VU University Medical Center approved the study, and all patients gave informed consent. If a patient was unable to give informed consent because of cognitive impairment, a proxy was approached.

Interview

Four factors were specified that might influence the maximum potential preventive effect of hip protectors: (1) hip fracture occurred in persons having a low risk (no indication for hip protectors), (2) hip fracture was not the consequence of a fall, (3) hip fracture occurred during circumstances that preclude the use of hip protectors, and (4) hip fracture occurred during the night.

In the first part of the interview, how great the predicted risk of fracture was immediately before the hip fracture occurred was retrospectively assessed. Questions on five risk factors for fractures were asked: fracture since the age of 50, prevalent vertebral fracture, low body weight (<60 kg), more than 4 weeks in bed or wheelchair during the previous year, and corticosteroid use (≥ 7.5 mg prednisone equivalent per day). The Dutch Guidelines for Osteoporosis have recommended these risk factors, which experts invited by the Dutch Institute for Healthcare Improvement developed.[5] In the second part of the interview, the circumstances of the hip fracture were explored. The time and location of the fracture, whether it was the consequence of a fall, during what activity the fracture occurred, and what the perceived cause of the fracture was were asked about. These questions were based on questions used during an earlier study.[14] The participants were interviewed within a few days after the hip fracture when they still were in the hospital. In case of cognitive impairment, a proxy was interviewed.

Statistical Analyses

Frequencies and percentages were used to describe the study population, the prevalence of the risk factors for fractures, and the circumstances of hip fractures. To define the high-risk group, an absolute 10-year risk of hip fractures of 10% or more was chosen.[5] This cutpoint is consistent with the predictive models of the World Health Organization.[15,16] In Appendix 5 of the Dutch Guidelines for Osteoporosis, the absolute hip fracture risk for women and men in different age groups was calculated (www.cbo.nl). In short, women aged 70 to 79 with a score of 2 or higher and women aged 80 and older with a score of 1 or higher had an absolute 10-year risk on hip fractures of 10% or more. Men aged 70 to 79 with a score of 3 or more and men aged 80 and older with a score of 2 or more had an absolute 10-year risk on hip fractures of 10% or more. The scores assigned to each risk factor are presented in Table 1. Finally, by combining the results from both parts of the interview, the maximum potential preventive effect of hip protectors was estimated.

RESULTS

Over a 1-year period, 520 hip fracture patients aged 70 and older entered the emergency department of one of the five hospitals in this study. After checking the inclusion and exclusion criteria, 379 patients were approached for an interview. The majority of patients excluded were admitted from a nursing home ($n = 63$) or were transferred to another hospital ($n = 59$). Of the 379 patients who fulfilled the inclusion and exclusion criteria, 280 patients and 50 proxies gave informed consent. Of these, complete data on the risk factors for fractures was available for 299 patients. The baseline characteristics of these patients are presented in Table 2.

The risk for fractures according to the Dutch Guidelines for Osteoporosis is presented in Table 1. The most frequent risk factor was "having sustained a fracture

Table 1. Prevalence of Risk Factors and Predicted Risk of Fracture Immediately Before Hip Fracture (HF) (N = 299)

Risk Factor	Score*	HF Patients n (%)
Fracture since age 50	1	111 (37.1)
Prevalent vertebral fracture	2	51 (17.1)
Low body weight (<60 kg)	1	101 (33.8)
>4 weeks in bed or wheelchair during previous year	1	31 (10.4)
Corticosteroid use (≥ 7.5 mg prednisone equivalent/day)	1	8 (2.7)
10-year risk of fracture $\geq 10\%$		
Women		138 (62.7)
Men		6 (7.6)

* Risk score as defined according to the Dutch Guidelines for Osteoporosis. The score for each risk factor was summed to calculate the proportion of persons with a 10-year risk of more than 10%.

Table 2. Characteristics of Patients with Hip Fracture (HF) (N = 299)

Characteristic	Value
Age	
Mean ± SD	82.7 ± 6.9
70–79, n (%)	97 (32.4)
≥80, n (%)	202 (67.6)
Sex, n (%)	
Women	220 (73.6)
Men	79 (26.4)
Living situation before HF, n (%)	
Independent	209 (69.9)
Home for the elderly	87 (29.1)
Psychiatric hospital or ward	3 (1.0)
Dress independently before HF, n (%)	
Yes	252 (84.3)
No	47 (15.7)
Type of HF, n (%)	
Femoral neck	178 (59.5)
Trochanter	110 (36.8)
Unknown	11 (3.7)

since the age of 50." Immediately before the hip fracture occurred, 138 of 220 women (62.7%) and six of 79 men (7.6%) had an absolute 10-year risk of hip fracture of more than 10%. In persons aged 80 and older, 119 of 153 women (77.8%) and six of 49 men (12.2%) had an absolute 10-year risk on hip fracture of more than 10%.

The circumstances of the hip fractures are presented in Table 3. Most fractures occurred in the afternoon (36.8%). Peaks in the occurrence of hip fractures were observed from 10:00 to 11:00 a.m. (10.4%) and 3:00 to 4:00 p.m. (11.0%). In total, 204 persons (68.2%) fell inside, and 93 (31.1%) fell outside. The most frequent locations inside were the living or dining room (19.1%); bedroom (15.4%); kitchen (8.0%); and entrance, vestibule, corridor, or landing (7.7%). The most frequent locations outside were the pavement or sidewalk (12.7%), public road (9.4%), and private outside surroundings such as the garden or balcony (5.7%).

The maximum potential preventive effect of hip protectors can be estimated using the above results. In the calculations, it was assumed that only 16% of the hip fractures occurring during the night could have been prevented, because the maximum compliance during the night was 16% in the Amsterdam Hip Protector Study.[17] According to the risk score of the Dutch Guidelines for Osteoporosis, 138 of 220 women (62.7%) could have been offered hip protectors because of high risk. In 32 of 138 women at high risk (23.2%), it is unlikely that the hip protector could have prevented the hip fracture, because the hip fracture was not the consequence of a fall or occurred at night or in circumstances under which a hip protector cannot be worn. This percentage was not calculated for men, because the predictive value of the risk score for fractures was low in men in this study. When providing hip protectors to women at high risk of fractures, 48.2% (62.7% × (100–23.2%)) of all hip fractures could have been prevented.

Table 3. Circumstances of Hip Fracture (HF) (N = 299)

Circumstance	HF Patients n (%)
Time of day	
Morning	89 (29.8)
Afternoon	110 (36.8)
Evening	69 (23.1)
During the night	23 (7.7)
Unknown	8 (2.7)
Location	
Inside	204 (68.2)
Outside	93 (31.1)
Unknown	2 (0.7)
HF was consequence of fall	
No	4 (1.3)
Yes	283 (94.6)
Unknown	12 (4.0)
Activities during HF	
Walking	93 (31.1)
Cycling	27 (9.0)
Turning	26 (8.7)
Reaching	24 (8.0)
Toileting	20 (6.7)
Other	109 (36.5)
Cause of HF*	
Loss of balance	158 (52.8)
Tripping	66 (22.1)
Wrong step	63 (21.1)
Being in a hurry	55 (18.4)
Not being careful	54 (18.1)

* Participants were asked whether each separate cause contributed to the fracture.

DISCUSSION

Several clinical trials of hip protectors have described acceptance of and adherence to hip protectors. This study went further by examining the maximum potential preventive effect of hip protectors in those persons who theoretically could have been wearing them. In a study of 299 patients presenting with hip fracture, taking into account patients at low risk of hip fracture, those whose fracture did not result from a fall or those who were engaged in activities where hip protectors were unlikely to be worn, the maximum potential preventive effect was 48.2%. This was before any apparent effect of refusal or nonadherence was allowed for.

A few remarks about the used risk score for fractures should be made. First, the risk score is usually used to advise about bone density measurements. It is probable that some of the persons with a high risk according to this risk score do not have osteoporosis as defined by the World Health Organization (i.e., a T-score for bone mineral density lower than–2.5). Second, the risk factors in the Dutch Guidelines for Osteoporosis, as in most risk scores for osteoporosis, are mainly based on studies conducted in women. This may explain the low predictive value in men in this study.

Hip protectors may be prescribed not only to persons at high risk for osteoporotic fractures but also to persons at high risk for recurrent falling. When using a risk score for recurrent falling, approximately the same results were

found (data not shown).[18] Almost 30% of the hip fracture patients in this study had had two or more falls in the year preceding the interview, and the maximum potential preventive effect was 51.7%. When comparing both risk profiles, the agreement (number of persons at low risk according to both risk scores plus number of persons at high risk according to both risk scores divided by the total number of persons) was 60%. This is reasonably high agreement, whereas the two risk profiles predict two different but related outcomes.

Strengths of the study are that it was conducted in a representative sample of the Dutch hip fracture population and that is it the first study that makes clear in which cases hip protectors are not likely to be effective in preventing hip fractures. Limitations of the study include the fact that the risk score was assessed retrospectively and that, in case of cognitive impairment, proxies were interviewed. In addition, the sample size for male participants was small. Finally, the prevalence of vertebral fractures was assessed according to self-report. It is known from the literature that approximately two-thirds of vertebral fractures can only be diagnosed using radiograph.[19] Therefore, it is likely that the predictive value will improve when using radiographs.

To improve the preventive effect of hip protectors, better selection procedures are needed. Prospective studies with large study sample sizes should be conducted to improve the predictive value of existing risk scores for hip fractures, especially in men. It may be interesting to develop a risk score for hip fractures based on risk factors for osteoporosis and for recurrent falling.

In conclusion, when providing hip protectors to women at high risk for fractures, it was estimated that approximately half of all hip fractures in older women living in the community or homes for the elderly cannot be prevented, because they occur in the low-risk group or under circumstances that preclude the use of hip protectors. This calculation was made assuming that all women were wearing correctly positioned hip protectors during the daytime. The actual preventive effect will be lower and depends on acceptance of, adherence to, and effectiveness of the hip protector.

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